University of California
Lawrence Livermore National Laboratory
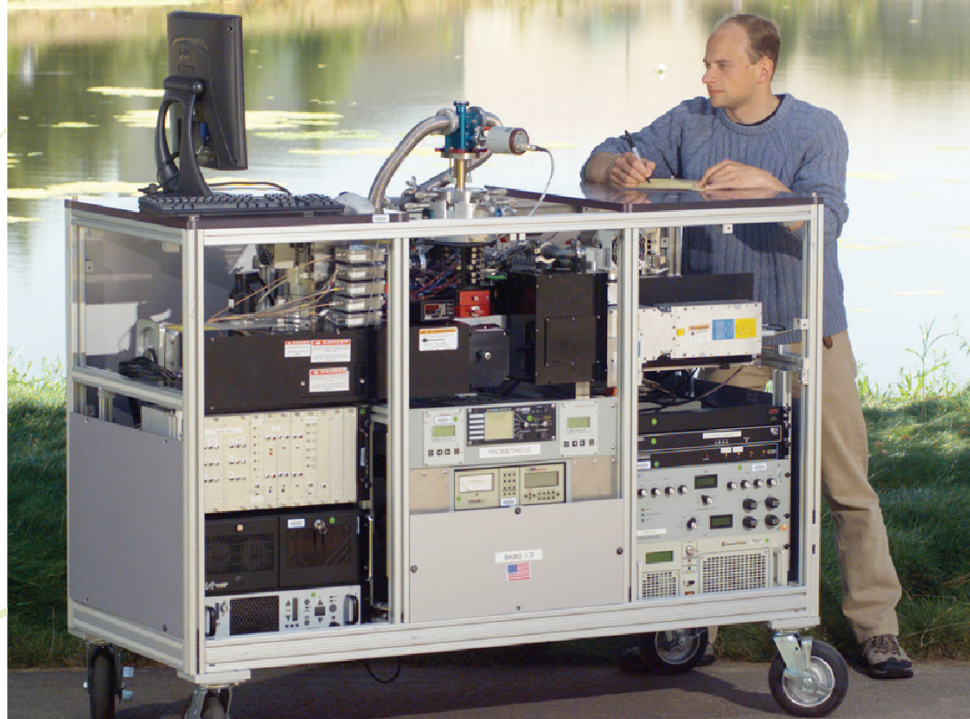

THE BAMS BREAKTHROUGH

BAMS can obtain and analyze mass spectrometry signatures of pathogens with the accuracy to differentiate species and with detect-to-warn speed.

HOW BAMS IS BETTER

- Detection of airborne spores, bacteria, and viruses with single-particle sensitivity—up to zeptomolar (10^{-21} molar) sensitivity in detection of certain biomolecular markers.

- Detect-to-warn speed (<1 minute).

- Demonstrated performance with no false alarms at 92% sensitivity.

In addition, BAMS:

- can be integrated with facility air systems.

- is remotely controllable.

- has potential applications in microbiology, public health, and oncology.
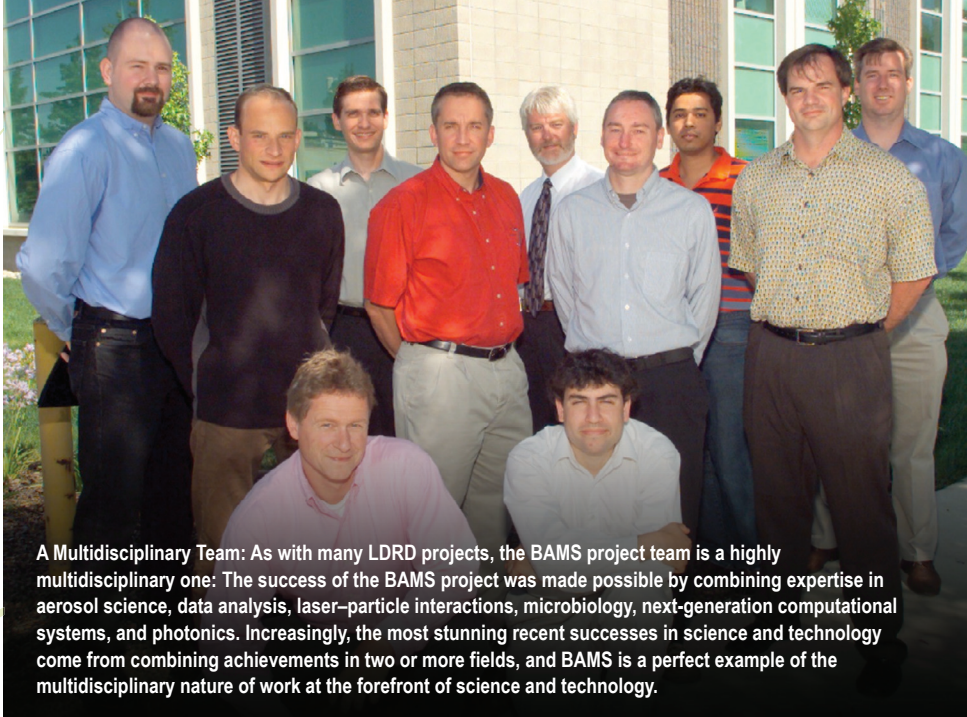
BIOAEROSOL MASS SPECTROMETRY (BAMS): IDENTIFYING AIRBORNE PATHOGENS IN TIME TO SAVE LIVES

DEVELOPMENT OF BAMS

- LLNL's Laboratory Directed Research and Development (LDRD) Program in 1999 begins funding work on a portable device for the realtime detection of airborne pathogens, such as anthrax spores.

- In 2001, a BAMS prototype is taken to Florida to screen suspicious powders sent to the Florida Department of Health in the wake of anthrax exposures in the U.S. Postal Service.

- Additional R&D support is provided by the Technical Support Working Group in 2001 and by the Defense Advanced Research Projects Agency in 2003.

- In 2005, the Department of Homeland Security field-tests BAMS at San Francisco International Airport to verify its performance in an actual operation environment.

- BAMS wins an R&D 100 Award in 2005. (Given by *R&D Magazine*, the Awards recognize the 100 most technologically significant products and advancements of the year.)

- Future applications include the real-time detection of respiratory diseases (by detecting pathogens in exhaled breath) and certain types of cancer (by detecting molecular changes in individual cells during normal and abnormal cell growth and cell death).

A Multidisciplinary Team: As with many LDRD projects, the BAMS project team is a highly multidisciplinary one: The success of the BAMS project was made possible by combining expertise in aerosol science, data analysis, laser–particle interactions, microbiology, next-generation computational systems, and photonics. Increasingly, the most stunning recent successes in science and technology come from combining achievements in two or more fields, and BAMS is a perfect example of the multidisciplinary nature of work at the forefront of science and technology.

HOW BAMS WORKS

After air is drawn into the device, tracking lasers determine the velocity of particles in the sampled air. Each particle is probed using laser-induced fluorescence, and particles having fluorescence properties of interest are shattered into ions with a desorption–ionization laser. The ions are then analyzed with a time-of-flight mass spectrometer to determine the mass-to-charge ratio of each ion. The result is a mass spectral signature (see below) for the particle. The signature is compared against those of known particles until a match is found, thus identifying the particle type.
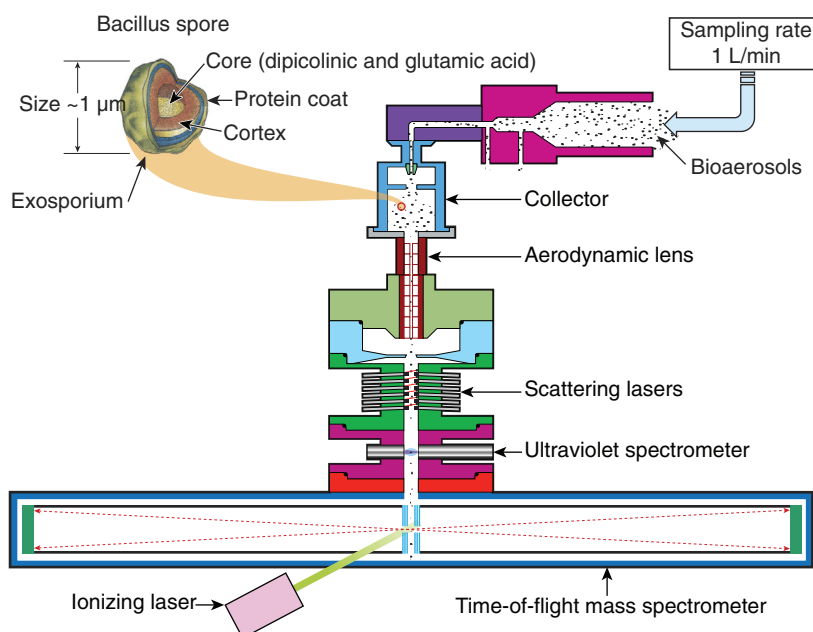
BAMS SIGNATURES

These signatures represent the spectra produced when two different species of *Bacillus* were analyzed using BAMS: a surrogate of anthrax (*B. subtilis var. niger*) and a commonly used organic pesticide (*B. thuringiensis*). BAMS signatures showed subtle differences between the two species, proving its ability to distinguish between harmful and similar but harmless species.